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Towards Quality Assurance in Statistics Education for Non-statistics Students at Palestinian Universities

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Abstract: Increasing emphasis is being placed on statistical skills and knowledge in the Palestinian curricula within the mathematics curriculum at all school levels in Palestine to establish a knowledge society. Furthermore, the application of information and communication technology (ICT) in statistics education has provided the opportunity for delivering good quality statistical education. The subject of discussion in this paper is to examine to what extent is the quality of statistics education assured, and whether continuous improvement in its quality is being planned and implemented for students in various disciplines at the Palestinian universities.

The aim of this paper is to examine the quality of statistics education to non-statistics students, and to propose a new framework for quality education in statistics that can be applied to Palestinian students. Challenges in statistics education in different countries, as well as the potential for their development using new available technology are discussed. Statistics educators face major challenges in teaching statistics courses for non-specialists not only in Palestine, but all over the world, where they face common challenges.

Besides, most Palestinian universities suffer from poor student/teacher ratios, large class sizes, and inadequate computing facilities, particularly for students in social sciences, education and business-related fields. Nevertheless, the majority of students spend much of their time outside the campus for using computers and going online. Much statistical software is accessible by Palestinian students, such as SPSS, Minitab, Excel and R. The major challenges that are faced by statistics educators all over the world are discussed here, and their statistical significance on Palestinian students is examined. The main proposal in this paper is that statistics curricula should be revised and computer oriented, with assignments using

real datasets, and case studies related to the students' own fields, and from the local Palestinian culture. The paper also stresses the need for preparing textbooks that illustrates the statistical methodology, as well as software description with many case studies and real datasets.

Key Words: Palestinian Curricula; Quality of Statistics Education; Case Study; GAISE Report; Discriminant Analysis; Excel; Minitab

1-THE PROBLEM:

Statistics in Palestine is presently taught in schools at all levels after the third elementary level. This forms part of the mathematics curriculum with some introductory elements of probability theory. The new Palestinian curricula started to be applied gradually at school levels since the year 2000, and since 2010, is being applied at all levels. However, despite the introduction of substantial developments in statistics education at schools, statistics education in Palestinian universities, particularly for non-statistics students remains unchanged. Statistics curricula for non-statistics undergraduate programs still favors theory over application, and attracts attention over practice and competency, as described by Kurji, *et al*. (2010) and Bazargan (2005).

The development of the new Palestinian curricula, and the inclusion of many statistics and probability subjects within the mathematics curriculum at all school levels was introduced from the third elementary level. The demand of workplace statistical competencies, as well as students' expectations, should shift the focus of academics at university level to the interpretation of statistical results rather than on rote and memorization of theoretical mathematical concepts as described by Moore (1997).

Equipping students with opportunities to develop their skills and abilities as practitioners of statistical analysis is essential for the quality measures at statistics education, and for students to be sufficiently outfitted for the world of labor (Gal, 2002). This level of skill and understanding is more important to those students taking statistics courses in social sciences, education, medical and health

sciences, and business-related fields. This requires the universities to provide all necessary resources, such as computing facilities, software, textbooks and tutoring to their students and faculty (Duller, 2008).

However, statistics educators in Palestinian universities suffer from having large numbers of students per class, and very limited resources which makes the achievement of those goals highly challenging. Moreover, many universities suffer from lack of qualified statistics educators. Several lecturers teach the same curricula that was taught to them many years ago, and many of them are graduates of universities in developing countries that suffer from the same problems. The goal of this paper is to discuss problems facing statistics education to non-statistics undergraduate programs in Palestinian universities, and to offer proposals towards solutions to these problems based on the review of statistics education in other countries, and some empirical data.

2-**METHODOLOGY:**

Much importance has been placed on statistical skills and knowledge in the last three decades in all developed and developing countries, to establish knowledge societies. As such, higher levels of participation at the tertiary education have seen an increase in student numbers in statistics education programs. Moreover, greater emphasis on statistics education has been placed at all school levels in those countries. The growth in statistics education in schools has brought greater diversity in student needs and expectations.

Therefore, a growing concern is the quality and purpose of statistics education, and all programs at the university level. Despite the increase in statistics and probability subjects at school levels, the question is: To what extent is the quality of statistics education assured, and is continuous quality improvement being planned and implemented at the university level? Furthermore, the application of information and communication technologies (ICT) in statistics education has provided the opportunity for the rapid development in statistics education for students of all disciplines. With an aim to promoting good practices in quality assurance in statistics education

in Palestinian universities at different disciplines, regional experiences of quality improvement is reviewed herein.

Statistics educators all over the world face major challenges in teaching statistics courses for non-specialists. In developing countries, they face other challenges, mainly the lack of teaching resources. In this paper, we review the literature on statistics education to identify those challenges and find ways of addressing them.

Data from a field survey gathered from students in different fields of specializations in different Palestinian universities are used to test the significance of the common challenges facing statistics education worldwide on statistics education in Palestine. The results are discussed, and the main findings are presented in this paper. Proposals to improve the quality of statistics education in the Palestinian universities based on the results of the statistical analysis of the field data and on the statistics education practices in developed countries and some developing countries are established. The recommendations we present for the improvement of statistics education to non-statisticians are analogous with the recommendations of the GAISE College Report (Aliaga, *et al.*, 2012).

3-**BACKGROUND:**

Analogous to many countries in the world, statistics in Palestine has been taught at schools since the year 2000 (Glencross & Binyavanga, 1996; Odgiambo, 2002). It forms part of the mathematics curriculum, with some introductory elements of probability theory starting from the third elementary level.

The reasons for including statistics education at school level in Palestine and many countries all over the world have been repeatedly discussed over the past three decades by Holmes (1980), Wild & Pfannkuch (1999) and Gal (2002). These reasons include the usefulness of statistics and rules of probability applicable in daily life, its instrumental role in other disciplines, the need for a basic statistical knowledge in many professions, and the important role of statistics in developing critical reasoning. The tendency towards a data-orientated teaching of statistics is shown in the curricular orientation for secondary school levels.

These curricula focus on developing statistical reasoning, which is different from mathematical reasoning. Both of them are essential to students, and complement each other in ways that strengthen the overall mathematics curriculum for students (Gattuso, 2006). However, these curricular recommendations are hardly ever followed in Palestine and many developing countries, as the teaching of statistics is frequently diluted or forgotten and, at best, taught in a formal way (Snee, 1993).

The teaching of statistics often consists of only performing computations or proving mathematical theorems with scarce opportunity to analyze data. As a consequence, students finish secondary school with no real understanding of the basic principles underlying data analysis. The provision of statistics within the school system in Palestine is noticeably unbalanced.

The syllabuses include topics like graphical representation and interpretation of relevant data which involves simple pictorial graphs, column or bar graphs, and pie charts, the calculation of the mean, median, and mode, range and standard deviation, as well as elementary ideas of probability of equally likely outcomes and mutually exclusive events. Clearly, the teaching of statistics at school level in Palestine at present appears to share the same approach as American schools as presented in GAISE PRE-K-12 Report (Franklin *et al*., 2007) and some of the European countries reviewed by Holmes (1994).

At the tertiary level, specialist statistics programs up to at least first degree (bachelor) level are offered by some universities in Palestine, with only three universities offering M. Sc. programs in statistics. Courses in applied statistics are provided for students pursuing majors in education, business-related studies, medical sciences, natural, and social sciences in all universities. Statistics for social sciences and business-related majors is covered in two separate courses in many of these universities.

They include basic statistics, such as the collection, presentation, and interpretation of data, the calculation of the mean, median, and mode, range and standard deviation, as well as basic probability concepts and traditional topics of inferential statistics:

sampling distributions, central limit theorem, confidence intervals, hypothesis testing for means and proportions, and regression and correlation.

The quality of statistics education to non-statistics students in Palestinian universities is adversely affected by inadequate teaching resources and shortage of qualified staff, as well as large class sizes. The average size of classes in social and business statistics courses, for example, usually exceeds 200 students. Teaching and learning resources that are important for quality teaching (Tsai and Wardell, 2006) such as up-to-date and relevant textbooks, reference books, journals, statistical software, local case studies and real datasets are inadequate or not available. Computer labs are totally mismatched when compared with the large class sizes, and are rarely available for teaching undergraduate level statistics courses.

Well known statistics software, such as SAS and MINITAB, are not available for those students. Only a limited number of LCD projectors are available in many universities, and rarely are they available to statistics classes. On the other hand, the majority of students possess laptops or desktops at home with MS Office, including Excel, installed. Students who do not have their own laptop or desktop still have access to computers at little or no costs.

The vast majority of students has access to the Internet and can download the R software free of charge. The intellectual and practical engagement of students taking statistics courses at different majors in the undergraduate level statistics curriculum (Cobb, 1993), possess significant challenges to faculty in many universities. Moreover, and analogous to students in developed countries, most students find statistical courses very difficult, uninteresting, inapplicable, and lifeless (Odgiambo, 2002). Statistics educators report frustration in integrating activities designed to energize student engagement in statistics courses.

4-CHALLENGES IN TEACHING STATISTICS IN DEVELOPED COUNTRIES:

Statistics educators all over the world face major common challenges in teaching statistics courses for non-specialists. One major challenge that has been identified in USA and European countries is that statistics subjects do not spark interest and curiosity the way that other non-statistics courses in the students' own fields do (Garfield, 1993). Statistics educators need to make deliberate efforts to enhance *motivation*. If business or social sciences students could choose to drop one required course from their curriculum, it would most probably be statistics (Lalonde & Gardner, 1993).

This is because the contents of statistics courses are math related and thought of as irrelevant to them. One way of motivating non-statistics students to study statistics courses is through mastery learning (Mevarech, 1983). That is, the goal is to achieve mastery of the material rather than simply to perform well at an exam. Mastery learning can help motivate students by setting up a clear goal state and a route for getting there.

Math anxiety is another challenge, and it is an emotional state of fear of future math-related activities. It interferes with statistics learning by lowering students' motivation as well as their efforts and achievements. However, reducing math anxiety could increase motivation and ultimately achievement. Hembree (1990) suggested that instructors cannot easily eliminate math anxiety through classroom interventions. One possible method of reducing math anxiety is through relieving exam pressure. This can be achieved through reducing the weight of the final exams of statistics courses and giving more weightage to homework assignments (Hembree, 1990).

Performance extremes in statistics appear evidently larger than in other courses among non-statistics students (Snelgar & Maguire, 2010). It is difficult to address the remedial needs of the low achievers while challenging the high achievers. Reaching both strong and weak students may require a proactive approach, in which the lecturer seeks out high and low achievers. Statistics educators can apply team-based approaches to problem solving by dividing students into teams of 4 to 6 students of different levels of achievements, and giving them special projects in practical

problems relevant to their own fields as team-based homework, and asking them to write reports on their statistical findings. Instructors can personally urge low achievers to learn from high achievers, and to hand in team-based homework assignments. The instructor needs to check the student's homework assignments closely and regularly. The proactive approach is, however, time consuming for the lecturer, but a teaching assistant can help.

Statistics educators, all over the world, noted that students remember little of what they learned in statistics. One reason is that statistics is thought of as a new language, or it needs a different way of thinking. Lalonde & Gardner (1993) showed parallels between learning statistics and second language, and argued that, with limited exposure, students do not achieve fluency. Perhaps only if educators intentionally infused statistics throughout other subjects would students show good retention. However, there are ways to increase retention from one semester's material. The most straightforward way to do this is to have the topics learnt in statistics courses related to the students' own fields of study through problem solving and case studies.

5-CHALLENGES IN TEACHING STATISTICS IN DEVELOPING COUNTRIES:

Statistics educators at the university level in the vast majority of universities in developing countries generally ignore what students learn in their secondary schools. Over the past decades, up to the 1990s, university-level statistics courses for students of social and business-related fields in the majority of developing countries used to emphasize the importance of variability, the planning and design of data collection, questionnaire design, levels of measurement, principles of probabilistic sampling (simple, systematic, stratified and cluster sampling), types of data collection methods, basic descriptive statistics, correlation and linear regression, and presentation of results and conclusions through the appropriate use of tables and graphs (Gutierrez & Ojeda, 2006).

They also introduce basic probability concepts and distributions, basic concepts of inferential statistics: sampling distributions, central limit theorem, confidence intervals, hypothesis testing for means and proportions. Until recently, the teaching of these courses has been a traditional chalk-and-talk affair. In the last few years, computers have become more freely accessible. At the same time, many statistical resources of high quality became available for students in developing countries, including computer-assisted statistics textbooks, electronic textbooks, and statistical software.

Statistics education in developing countries faces considerably more problems than in other developed countries. Inadequate numbers of qualified statistics educators, as well as large numbers of students have led to poor teacher/student ratios among statistics educators (Hernandez, 2006).

In most disciplines, statistics courses are taught as traditional mathematics courses, to a large number of students per class, by nonqualified instructors in many developing countries. Poor and out-of-date statistics curricula are taught. They are, in most cases, the same statistics curricula that the instructors themselves were taught decades ago. In fact, this created a problem of lack of specification of student learning outcomes including disciplinary and generic skills in statistics curricula. Generic skills may include statistical reasoning, ability to apply statistical knowledge in practical situations, or ability to communicate statistical information.

One important challenge facing universities in developing countries is that of finding out how instructors can help students overcome the difficulties they experience in studying statistics with very limited teaching and learning resources. Many universities suffer from inadequate infrastructure, such as reasonable computer and statistical laboratories, inadequate buildings and lecture theaters, and ICT infrastructure (Russell, 2010). Those universities are mainly in highly populated countries, and have limited budgets to invest on classroom buildings and infrastructure even if statistical educators in those countries have the ability and willingness to improve the status of statistics education. Therefore, any proposal

for the development of statistics education must be conditioned to overcome this impediment.

The majority of the universities in developing countries put up with inadequate or nonavailability of teaching and learning resources, such as up-to-date and relevant textbooks, reference books, scientific journals, and up-to-date statistical software. Such resources are available, to some extent, through the Internet, but they mainly came from American and European culture and environments with examples seen as eccentric to them. Students become interested in statistics as long as they see statistics applied to real problems that have meaning to them. Many authors suggest putting emphasis on teaching statistical thinking or reasoning, and embracing innovative teaching methods that emphasize interactive assignments, and the use of real data from the students' background (Garfield, 1993; and Verhoeven, 2006).

The lack of real datasets and case studies for teaching statistical courses and statistical thinking that come from real life and from the same students' fields and culture is one of the main challenges facing statistics educators in many developing countries. Gould et al. (2006) described the qualities of data that would be suitable for teaching statistical thinking. Datasets of such quality, however, are rarely available from local resources.

Many datasets used for teaching statistics in developing countries are mostly hypothetical data or datasets obtained from international Web-based data archives and electronic dataset libraries. A closer contact with real data from the international Web is also encouraged, but most of the datasets there come from American and European culture and environments.

Statistical educators in other countries sometimes apply extra efforts to describe the data because of the language and the cultural differences. When the data comes from problems related to the local community, students can recognize the importance of the statistical methods that can help them to explain and analyze the data and draw conclusions relating to their own problems.

6-CHALLENGES IN TEACHING STATISTICS IN PALESTINIAN UNIVERSITIES

Palestine has 19 universities with different sizes ranging from small to large and from poor to rich. Similar to other universities in many developing countries, Palestinian universities' budgets come from students' fees and some governmental subsidies, but some universities in Palestine are backed with international donor support. Most Palestinian universities offer the first degree (Bachelor) in social sciences and business-related majors.

Only a few universities offer a program leading to the B.Sc. degree in statistics. Only two Palestinian universities up to now, offer an M.Sc. program in statistics. No Palestinian universities offer a Ph. D. program in statistics yet. Palestinian statistics educators studied statistics in a wide range of countries like the USA, Europe, India, Malaysia, and some Arab countries.

Statistics educators in the Palestinian universities put up with the same challenges faced by their colleagues in other universities in other developing countries. They also suffer from the problems met by statistics educators in developed countries, including motivating students to study statistics, handling math anxiety, dealing with performance extremes, and making the learning memorable, as well as the other challenges met by their colleagues in developing countries, such as poor teacher/student ratios, inadequate infrastructure, inadequate or nonavailability of teaching and learning resource, and the lack of real local datasets.

Palestinian students live under harsh economic circumstances. Many students do not possess their own laptop or PC. In many faculties in Palestinian universities, English language is the main medium of instruction alongside the Arabic division which is their mother tongue. The author carried out a survey composed of over 200 students who studied at least one statistics course in various disciplines at different Palestinian universities; 62.5% possessed their own laptops or PCs at home which were available to them all the time.

The rest indicated that they had access to a laptop or a PC for a limited time only. No student indicated that he/she had no access at all to a computer. They indicated that their average daily time spent using the computer was 1.3 hours on the computer only, and 5.5 hours using the Internet. Moreover, 87.2% of the students indicated that they were able to search for information in the Web, 99% could use MS Word, 52% could use MS Excel, and 62.5% indicated that they could use MS PowerPoint. On the other hand, when they had been asked whether adequate university resources were available to them, only 29% answered yes, 57% of the students answered no, and 14% answered that the university provided all technological resources needed only to some extent. Detailed description and analysis of the survey can be found in Okasha (2013).

7-ADDRESSING THE CHALLENGES:

The discussion above indicates that students become interested in statistics and keep their interest in the subject as long as statistics is applied to data related to their own fields, and can be of help to them in solving problems that they were interested in. Case study method has long been held as an effective tool for increasing student engagement in statistics. The practice of bringing realistic applications and cases using data related to the students' own fields into statistics education is growing, in general Improved statistical computer packages, and the dilation of Internet-based access to datasets have significantly expanded the opportunities for statistical applications in respect of social and business-related problems, particularly those relevant to economics and sociology. Students regularly report that the case projects require considerable efforts, but are a key component in the contribution to their learning.

Case studies are particularly well suited for the business and social sciences majors because they are primarily interested in the study of business and economics, as well as social problems, and not mathematical statistics. Students are presented with situations that require statistical and economic or social analysis to solve a realistic problem. Written and oral reports addressed to high-level managers and policy makers, or merely a press release, are

particularly powerful teaching and learning strategies when used with the case studies.

Homework and class assignments should require written interpretation of data. Some of these writing assignments should require students to interpret the meaning of generated statistical data. For example, students should be asked to describe opinions regarding stock market fluctuation by presenting a variety of frequency and cross-tab distributions. Other questions could be to ask students to explore the veracity of a hypothesis by performing the appropriate statistical tests.

Students should always provide written interpretations of the data and the results. Simply calculating the correct answer ought not to be the main objective to achieving a passing grade. Raising the class assignments and case studies to a high level of influence in the students' final grade for the statistics subject will certainly alleviate the pressure in the final exam, and help in raising motivation and reducing math anxiety among students majoring in social and business-related fields.

Rarely in social and business-related fields are projects carried out in isolation. When incorporated into the curriculum, team-based approaches to problem solving and project development serve two fundamental and important roles; engaging students more fully into the subject matter by making the projects interesting and applicable, and preparing them for the joint accountability and collaboration that will be the hallmarks of their early professional experiences.

Team-based projects can be related to service learning, but more in general, team-based projects can be related to case studies, and can include written and oral presentations. Team-based approaches to problem solving can also be used to enhance retention of the statistical subjects and reduce the problem of performance extremes in statistics courses.

A brief examination of the available textbooks on statistics for nonstatisticians reveals that a large number of authors combine statistical software such as Excel, Minitab, or SPSS into their lecture materials (see Lane, 2012). As more faculty migrate their course materials to the Internet through products such as Blackboard

and WebCT, statistical software will play an increasingly central role in teaching statistics.

Barr and Scott (2011) described the teaching of statistics within a spreadsheet environment, whereby students are, inter alia, required to master the basics of MS Excel to perform statistical calculations from their experiences with a new teaching approach in an introductory statistics course involving some 1200 first year students in South Africa. They found that this approach has the advantages of developing the students' ability to work with data, while also building their understanding of the algebraic relationships between elements embedded in the spreadsheet formulae which they use.

The authors demonstrated the use of a classroom experiment aimed at exploring the statistical distributions of a number of pieces of information generated by the students. Teaching sessions are then built around a suite of MS Excel VBA-based simulations which demonstrate the concept of random variation, as well as showing how statistical tools can be used to explore the concept of uncertainty.

It is important to recognize that the use of Excel in teaching statistics has some drawbacks. The first is that we may come across some students who cannot afford to have their own laptop or PC. Moreover, students may have very limited prior experience in Excel, and it would be too much to try and teach both Excel and statistics from scratch in the program time, and in a typical classroom, usually allocated to the teaching of statistics. For this, students who have no prior Excel experience should be encouraged (or required) to attend an Excel course prior to the start of the statistics course.

Another problem encountered in the literature by some authors (Barr and Scott, 2011) in using Excel (and other statistics software) in statistics courses is that the instructor cannot assess the student's understanding, comprehension, and abilities without timed, in-class quizzes involving number crunching of data. Those authors think that to deal with quizzes (and examinations) within a limited time period, a student has to learn the formulas, how to use printed

distribution tables, and how to do numerical calculations with a pocket calculator.

Advanced statistical software, such as SPSS and R (with built-in case studies), allow for assignments to be introduced, and require students to discover statistical principles independently. Students can examine data to estimate the means, medians, modes, and standard deviations, and they can explore the concepts of central tendency and variation by creating frequency distributions using datasets provided by the software itself.

Introducing the students of education, social sciences, and business-related fields to an advanced statistical software, such as R and SPSS in their statistics course, allows them to handle development of technological competencies that can be utilized throughout the remainder of their academic tenure at their university, and throughout their career. However, most advanced statistical software are extremely expensive and not within the budget of many students and even some universities in Palestine.

The only advanced statistical software which is downloadable free of charge by all students is the R software. It is however, very difficult for teaching within a statistics course for students in an ordinary level. It may, however, be used for teaching to classes of well-endowed students.

The problem encountered by Barr and Scott (2011) and other authors regarding the instructor's inability to assess the student's understanding and abilities of the statistics course with in-class quizzes and exams, can be dealt with by testing the students through assessing their statistical reasoning, ability to choose the correct statistical method, interpreting data and results, as well as building of logical, clean, and defensible arguments rather than in memorizing formulas and their ability to do numerical calculations. Instructors can assess the student's understanding of the subject by giving quizzes and examinations of multiple choice nature, and through the assessment of their case studies.

Moreover, to overcome the problem of nonavailability of teaching resources, suitable textbooks which mobilize interesting real-world examples and case studies relevant to the student's own

fields of study, and supply seamless presentations that identify valuable connections between statistical applications and research design, should be printed and produced.

Producing a textbook covering all the topics of the course, and incorporating the proposed changes in teaching methodology is the cornerstone of teaching statistics. Those textbooks need to be class tested to ensure an accessible presentation, and should combine clear, step-by-step explanations and the use of software packages that are accessible to both the poor and the rich, as well as the novice and professional alike, to present the fundamental statistical practices for organizing, understanding, and drawing conclusions from the data.

Data coming from current research work are ideal for teaching. Students will remain interested in the subject and maintain their interest as long as the textbook is clear, and statistical methods are applied to data related to their own fields, particularly if the theoretical mathematical concepts were minimized (Gorman, 2008).

Setting the maximum class size to about 30 students would be ideal, and certainly would improve active participation and interaction of students in the classroom, and is an ideal solution for some more fortunate universities, but not so practical in many others. This is because that would not only require such universities to employ many more qualified statistics educators, but also it requires the universities and their governments to invest a high capital in the university buildings and equipments.

Alternatively, those universities can employ as many teaching assistants as needed to work under the supervision of qualified educators, with their role being limited to helping students in their assignments and case studies.

8-TOWARDS QUALITY ASSURANCE IN STATISTICS EDUCATION TO NONSTATISTICS STUDENTS:

We can see from the above discussion that statistics educators in developing countries face all challenges faced by statistics educators in developed countries in the face of the limited available financial resources, infrastructure, and teaching resources. For a realistic reform to achieve quality statistics education for non-statistics major students in the developing countries in general, and in Palestine in particular, any proposal must be constrained by the limited available financial recourses. The plan to achieve this reform relies on the following aspects:

1. Statistics subjects at school levels in Palestine should be in-class tested, revised, and developed, and should be given as a separate subject (independent of the mathematics curricula) to all students at all school levels (Franklin *et al*., 2007).
2. The teaching methods of statistics subjects at school levels in Palestine should be developed, and school teachers should be trained to follow curricular recommendations of Franklin *et al*. (2007).
3. Students in Palestinian universities assumed to have their own laptops or PCs, should be given free access to computers and the Internet.
4. All students should be able to install MS Excel spreadsheet in their computers, or install the R statistical software; and should be given training courses to use the software prior to taking the statistics course.
5. A collection of datasets in different disciplines should be built online and made available to all students through the Web, organized and arranged by their discipline and statistical methodology.
6. A collection of multiple choice questions with applications on social and business-related fields should be built and made available through the Web, and arranged by their discipline and statistical methodology.

7. Teaching assistants should be employed in statistics education to help students solve their homework assignments and case studies in their statistics course.
8. The assessment and grading strategies of statistics courses should be changed through allocating more weights to the homework assignments and case studies, than quizzes and final exams (like 60% for homework assignments and case studies and 40% for quizzes and final exams).
9. A series of readings with applications of statistical methodology in different disciplines should be produced and made available through the web, organized and arranged by their discipline and statistical methodology.

An effective statistics education, for nonspecialists, must strive towards the use of statistics in the real world. For this purpose, it is necessary to develop a clear sense of the relevance of statistics in real situations (Bradstreet, 1996). Some of these situations consist of applications specific to the student's field of study and regional concerns, but others may involve situations of general interest, or experiences in daily life. In any case, linkage with the real world is necessary for understanding the kinds of questions where statistics can help.

Cooperative efforts involving statistics educators at the national, regional and international levels should be encouraged for the benefit of quality statistics education. Textbooks focused on statistical concepts, principles and analysis of real data related to the students' own field, would contribute greatly to making the statistics course an attractive and enlightening course for social sciences and business-related students. A substantial literature base should be developed which posits that student intellectual and academic engagement will be enhanced significantly when traditional classroom lecturing is supplemented with one or more Internet-based course material.

Course management software products would provide tremendous flexibility in providing students with additional course materials, providing ready access to data, links to statistics resources and data banks. These course management tools, if made available

by universities in Palestine, would very much facilitate student learning and engagement outside the classroom.

The above recommendations which are given to achieve quality statistics education in Palestinian universities to nonstatisticians, coincides with the six recommendations of the GAISE College Report (Aliaga, *et al.*, 2012). These recommendations can be summarized as follows:

1. Emphasize statistical literacy and develop statistical thinking.
2. Use real datasets in teaching.
3. Stress conceptual understanding, rather than mere knowledge of procedures.
4. Foster active learning in the classes.
5. Use technology for developing conceptual understanding and analyzing data.
6. Use assessments to improve and evaluate student learning.

9-CONTINUOUS QUALITY IMPROVEMENT IN STATISTICS CURRICULA:

One of the most important implications of the above results is that continuous quality improvement should always be sought to improve the provision of statistics education with an emphasis on future results to ensures that every high-school graduate should be able to use sound statistical reasoning to intelligently cope with the requirements of citizenship and future employment.

This requires not only continuous curricular development of statistics and probability subjects, but also curricular recommendations that the quality of teaching methods at school levels be continuously revised and tested in-class. Statistics and probability subjects at school levels in Palestine should be taught as separate subjects to all students to avoid repetition and create a basis for the university level.

The subject matter for these subjects should be derived from the specification of student learning outcomes, including disciplinary and generic skills in statistics curricula. The university-level statistics course, however, should be comprehensive, and applied purely by using appropriate and available statistical software, and should be taken by all undergraduate students in social sciences and business-

related fields. The subject matter should concentrate on statistical reasoning, ability to apply statistical knowledge in practical situations, or ability to communicate statistical information.

The aspects discussed above are certainly needed to achieve a realistic reform to achieve quality statistics education for nonstatistics major students in Palestine. Moreover, achieving statistical competencies requires that curricular focus should be shifted to the interpretation of statistical results rather than on theoretical mathematical concepts.

The formulation of a statistics question requires an understanding of the difference between a question that anticipates a deterministic answer and a question that anticipates an answer based on data that vary. This means that, in the design of any statistics course, a list of appropriate overall program objectives that fits well with the above results should be clear from the beginning.

One interpretation of a set of overall program objectives for a practical skills decision, and global oriented program that would be relevant to the teaching of statistics within that framework is that students should be able to:

- Apply statistical knowledge in practical situations relevant to the students' own field of study and regional concerns, arrive at sensible solutions, and implement necessary change
- Effectively communicate statistical information, and ideas through formal presentations of statistical results, written reports, and group discussions
- Receive statistical results presented by others critically and respond appropriately.

Statistics educators can contribute to these overall program objectives in many ways, such as choosing suitable case studies and datasets that can contribute to the general understanding of the effective variables in the data, and how a common understanding of data can contribute to the analysis of the problem's dimensions. Choosing cases or examples where the use of data, supported by statistical analysis, leads to improved decision making, and develops students' ability to analyze important problems and arrive at sensible solutions.

Examples that provide practice in Excel and/or exposure to functions or features of Excel that are new to students, contribute to developing more general problem analysis skills. Finally, group assignments accompanied by a presentation to the class, or a written report, contribute to developing students' teamwork skills.

From the above overall program objectives, we should define the course objective that is needed for designing the course. For example, a good statistics course objective would be that, after completing the statistics course, students should be able to:

- Use data to improve their decision making
- Present data or statistical results informatively
- Analyze data and draw statistical conclusions from data correctly, and
- Understand data and analysis' results when it is presented to them, ask useful (perhaps probing questions), and respond appropriately.

These objectives emphasize developing students' skills at working with and using data, and producing students who can actually do things using statistics, as opposed to producing students who understand statistical theory. Doing things is taught usually through practice, and a course with these objectives should be loaded with problems and examples that students can use to practice application of the concepts that they are learning. The overall program objectives can be further supported if the problems that the students work on are real datasets from the students' own background.

The emphasis on real problems suggests the use of a software to facilitate performing the statistical calculations, and here, statistics educators have a choice between using a special-purpose statistical software (such as Minitab, SPSS or R) or the general-purpose Excel spreadsheet. The case is in favor of using Excel in Palestine because it is widely available and is now quite standard, and there is no setup cost to using Excel: most students have used Excel before the course.

However, Excel is another skill that must be learned as the students master statistical concepts; the additional skill acquisition

can become an obstacle (Giles and Ganesh, 2002). Furthermore, the built-in functions of Excel may obfuscate the underlying statistical concepts from the student, reducing comprehension of these concepts. The other alternate free statistical software is R which can be a very good tool for Palestinian students, although it is more difficult to learn. The R software can be used for teaching statistics to nonstatisticians at the postgraduate level, or to classes of better endowed students. The shortage of teaching and computing facilities, textbooks, reference books, and scientific journals in the process of teaching statistics in Palestinian universities calls for producing of modified and up-to-date statistics textbooks, and making them available to all students. The success of an introductory statistics course depends to a great extent on the available textbook. American and European statistics textbooks are not suitable for teaching statistics to students at different disciplines taking statistics course in the developing countries.

This is because most of their examples and data are not attractive to students, either because of their hypothetical nature, or by not being related to the local social or business issues. Textbooks should put emphasis on teaching statistical thinking and reasoning, with many real-life examples from the Palestinian culture, illustrating the relevance of statistics to understand issues related to the student's own fields of study, and making statistics courses attractive and enlightening for students, as well as embracing innovative teaching methods that emphasize active learning, interactive assignments and the use of real datasets. The use of the statistical software should be fully described in the textbooks with enough examples to illustrate all aspects of the software.

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